

SPEECHES AT THE ROYAL ALBERT HALL, 23RD SEPTEMBER, 1931, AT
THE OPENING OF THE FARADAY EXHIBITION.

Mr. C. C. Paterson: The heritage of good things we receive from the past is sometimes overlooked by the individual but is seldom entirely forgotten by him, for most men try to hand on to the future something of what they receive, transformed by the impress of their own efforts and of their own personality. This is the only way in which the ordinary individual can repay the great debt of inheritance. A community can, however, do more than an individual; it can use its resources to testify to the world in many ways its sense of obligation and of admiration. This Exhibition is the way chosen by the electrical engineers, chemical engineers and men of pure science of this country, to remind their fellows in the British Commonwealth and to remind their colleagues in science and engineering in all parts of the world, of Michael Faraday—a man who was great in his achievements but who was greater still in the genius which inspired him, and in the modesty and simplicity of his character. It is fitting that one of the most respected citizens of the Commonwealth overseas should open this Exhibition. We welcome General Smuts not merely because he is a great South African, but also because his outlook on the world is so wide and catholic. If one may recall a saying of Goldsmith's, there are a few men whom one feels are first and foremost citizens of the world. I always feel that General Smuts is one of these. I have the honour to call upon him to address us.

Lieut.-General the Rt. Hon. J. C. Smuts: This Exhibition forms the central feature of the celebrations in connection with the Faraday Centenary now going on. During this week of homage to the memory of Michael Faraday, you have heard and you will still hear tributes from famous representatives of many sciences to this great master of science. To-day it is the privilege of the electrical engineers of Great Britain to take up the tale. Their Institution has done me the great and unexpected honour to ask me, as president of the British Association, to open this Exhibition. I need not say how happy I am to take part in this most memorable and historic occasion. The action of the Institution is all the more welcome because this procedure enables the British Association also to pay their proud and grateful tribute to a scientist who was one of their leading ornaments and strongest supporters in the day of small and difficult beginnings. This Exhibition serves no propaganda or publicity purpose; it is simply and solely an act of homage to Michael Faraday, the man and the scientist. You will notice that his statue occupies the centre of the hall, and round it are grouped many interesting relics and mementoes of Faraday the man. Then, radiating from this centre, are eight segments: the tables at the narrow inner ends of these carry reproductions of the fundamental chemical and electrical experiments in which the most pregnant of Faraday's classic discoveries had their origin or their verification. In

some of the demonstrations which you will see, the actual apparatus of Faraday will be used. Then, where the segments expand towards the circumference, there are illustrations of the practical results of his fundamental discoveries; they represent the triumphs of modern science which have done so much to create the social, industrial and commercial world in which we live to-day. Light, power, transport and instantaneous world-wide communications are all illustrated here, as part of the harvest which mankind has reaped from the labours of Faraday. These practical applications Faraday left mostly to others, and to time; with the pride of the born creator, he was most deeply interested in fundamental research. His achievement in pure science is in many ways even more significant than these practical applications, immense as they are. I congratulate electricians that they can claim as their own, as their foremost figure, one who may rightly be considered to be the very ideal of a scientific man. Science, like religion, has its patron saints. In Faraday the votaries of electrical science have a patron saint worthy to be ranked with the highest in the religious calendar. Men of science sometimes share with the rest of us the weaknesses of human nature. But in Faraday we have one in whom high scientific genius was combined with the most touching simplicity, purity and nobility of character; one who, like the great Puritan poet, lived "as ever in his great taskmaster's eye"; not only a king of thought but also a humbler elder in the Sandemanian Society—visiting the poor and comforting the sick and suffering, while he was in the midst of his epoch-making researches. To think of Faraday the scientist, is to be conscious of our own insignificance beside towering genius; to think of Faraday the man, is to feel ourselves several inches taller as men. His career is a rare romance and a tribute to human nature at its best. Born and nurtured in poverty, he early made the great renunciation and chose to remain poor for the sake of science. He began with no initial advantages, no stimulating surroundings, no academic associations or training. From bookseller's apprentice and journeyman bookbinder, a kind fate led him to become bottlemasher to Sir Humphry Davy, and his feet were then firmly set on the great adventure of science. He asked little of life; his passion was science; his ecstasies were those of scientific experiment and discovery. Has it ever been given to mortal man to feel the rapture of scientific discovery more than Faraday felt it? He found electricity not a science but a scientific curiosity, an affair of curious phenomena with which a few scientists dabbled. He left it as a fully developed science with its foundations firmly laid and a stable superstructure constructed thereon, which gave it a foremost place among the physical sciences. Almost alone and single-handed, he did for electricity in two decades what a host of great discoverers had combined to do for chemistry in a period several times as long.

Such is the stride of genius. Luckily for him, his exploration was over virgin territory; he had no oppressive literature to read, no woolly theories of others to mislead him. With the sure insight of genius, he read the riddle of his experiments in a way which the subsequent labours and reflections of others have only served to confirm. Faraday was probably the greatest experimenter in the history of science. But the wonderful thing about him is not only his rare skill, resource and success as an experimenter, but also his scientific insight, his sureness of intuition, and his prophetic anticipation of later developments. His uncanny power of scientific imagination—I had almost said, of scientific divination—has put him in the very front rank of scientific genius. Not infrequently the labours and discoveries of great scientists lie off the true line of advance, and consequently lack the qualities of suggestiveness and fruitfulness which are the hallmark of true genius. The great creators in science, as in other departments of life, are those whose work is dictated by a true conception of the nature of their science, and who therefore follow the predestined route along which alone it can advance in future. Of such a character was Faraday's work and such was his conception of electromagnetism. For the croneous notions of the electric fluid and action at a distance, which he found current, he substituted the fundamental conception of the electromagnetic field with its stresses and strains and its lines of force. His immediate contemporaries, while highly valuing his experimental work, were inclined to look upon his novel conceptions as vague and imaginative. His successors, however, have found in those conceptions his greatest contributions to science and the clues to future advance. Clark Maxwell found that they fitted the phenomena far better than the orthodox views and that they could be readily translated into the language of mathematics. Maxwell's celebrated equations of the electromagnetic field, which followed up Faraday's work, have become the basis of most subsequent developments in electrical theory and science. In this way Faraday has become the founder not only of electromagnetism and, indirectly, of electrical technology and industry, but also of many more recent developments in pure and applied electricity which have revolutionized the newer physics. One may say, without exaggeration, that for many of the most striking recent developments, Faraday's conceptions in electromagnetism originally blazed the trail. He ranks with the greatest among the masters of science in his intuitive reading of the material world, in the amazing lead he has given to subsequent research and thought, and in the enduring character of his main conceptions. Faraday's scientific insight is further indicated by another significant fact. Although his work was mostly done at a time when the principle of the conservation of energy had not yet been formulated, all his investigations proceeded on the assumption of that principle. He sensed the great truth before it had been formulated; in his researches he looked for continuity and compensation everywhere. Hence his repudiation of action at a distance; hence also his belief that all forms of energy were in the end reducible to one—that there was (as he put it) "a common link binding together all the forces which in each branch of physics—gravity, electricity, magnet-

ism and chemistry—had been treated as peculiar to that branch;" hence, too, his correlation of electric and magnetic exchanges in such a way as to presuppose the validity of the laws of energy. Although he did not directly state or prove it, the principle of conservation was a tacit convention in all his experimental procedure. His instinct for fundamental principles was as sure as his experimental skill was rare. The greatness of Faraday as a scientist can be gauged from another point of view. The two principles of the conservation of energy and of organic evolution are generally considered to be the most fruitful and significant generalizations of science in the nineteenth century. With these we have undoubtedly to bracket a third great generalization—the laws of electromagnetism. Recent advances in physics have given to these laws an added importance, and to-day it may be said without contradiction that these laws are of fundamental importance for all physical science. The very constitution of matter has turned out to be electrical: the ultimate pre-atomic constituents of the world are electrical; and electromagnetism has ousted chemistry as the fundamental physical science. The governing concepts and experimental principles which underlie the laws of electromagnetism were the achievement of Faraday; his successors have but built on the foundations which he laid with masterly skill and insight. To him, therefore, should be assigned the credit for one of the three supreme scientific generalizations of the last century. Having said all this about Faraday, the scientific genius, I return to the personal note on which I began. There is a simplicity and unself-consciousness about Faraday which is most intriguing and is almost Shakespearean in its quality.

"Others abide our question; thou art free.

We ask and ask—thou smilest and art still."

What passed in that modest soul? Was he aware of his place in science, of his royal status in the realm of science? He was apparently one of those rare types of genius which embody truths beyond their own consciousness, and resemble the great works of Nature in their suggestiveness and inexhaustible fruitfulness. No wonder that his stature has grown since he passed away more than 60 years ago, and that to-day he is acclaimed as he never was in his own lifetime. This Centenary Exhibition is the witness which electromagnetism bears to its founder, the tribute which the vast company of electricians the world over bring to their leader and patron saint. I now declare this Centenary Exhibition duly open.

Colonel R. E. B. Crompton: It is indeed a great honour for such an old man as I am to return thanks to General Smuts, one of our great men. General Smuts was once my enemy. Thirty-one years ago he was at the end of one machine gun and I was at the end of another, and our feelings at that time are best left undescribed; but it is only fair to say that at that time I began to appreciate that our enemies, the Boers, possessed a peculiar quality—that of chivalry. I believe that one of the great inspirers of that quality was General Smuts. General Smuts is a great inventor, although he has not acclaimed it himself. After studying

all the problems of the present time and how far we have progressed in a material age, he found out that something was still wanting. He gave his invention the name of "holism." Holism is something very difficult to describe, but I gather that it is the power which any individual has of inspiring enthusiasm in others, of getting others to work with him and in that way securing success. Everybody who has done anything useful in this world has not done it by himself alone but by the help of his holism, by getting round him a staff of co-workers who work with him heart and soul; that is to say, by possessing the power of being able to put holism into others. In these days we are constantly being told that Capitalism and Labour clash. If they do, it is because of the want of holism on the part of everyone concerned. I am still at the head of a very big firm, and our success is entirely due to holism between everyone involved—the directors, the staff and the workmen. It is easy to find out whether holism exists in a works; one has only to walk round and glance at the faces of the workmen; if they return the glance with a look of understanding one can be certain that there lies the source of success. Consequently we owe a great deal to this discovery. General Smuts has put a name to a feature which is not sufficiently understood, and the absence of which has caused much commercial disaster. At the time when I first met General Smuts electricity was just beginning to be employed in warfare. In 1899 I was sent for by the War Office and asked to get together a corps of scientific men who could apply what we knew then of electrical apparatus to the purposes of the Army. The equipment was to be used very largely for the purpose of giving light and power, and for providing what were then called "Röntgen rays," but are now called "X-rays," in the hospitals; but above all the electrical plant was designed to enable us to work at night on repairs. During the last four years I have followed with great pleasure the philosophic theories of General Smuts; we older engineers are apt to be a little puzzled by the work of Einstein, Eddington, Jeans and others, who make us think in such gigantic figures that we hardly know where we are. The conception of holism, however, is extremely valuable to everyone at the present time, and it proves General Smuts to be a very great man. Those present in this hall have come from all parts of the world to do honour to the great name of Faraday, and I am sure you all share with me the pride I feel in this splendid gathering of the leading minds of the electrical world.

Dr. F. B. Jewett:* To you, Mr. Chairman, to General Smuts, and to all those who have gathered in London to-day to commemorate, in the opening of the Faraday Exhibition, the centenary of Michael Faraday's great discoveries, I bring the greetings of the scientific societies and the men and women of science of the United States. In particular, I have been asked to convey to you the

felicitations of the following societies which were invited to participate in the functions you have organized to evidence the world-wide appreciation of the debt we owe to this great man: National Academy of Sciences, American Philosophical Society, American Association for the Advancement of Science, American Academy of Arts and Sciences (Boston), New York Academy of Sciences, American Mathematical Society, American Physical Society, American Chemical Society, Franklin Institute, American Institute of Electrical Engineers, American Society of Mechanical Engineers, Institute of Radio Engineers, American Electrochemical Society, Illuminating Engineering Society, National Electric Light Association, Association of Edison Illuminating Companies, and National Electric Manufacturers Association. Most, if not all, of these institutions are represented in London by their delegates. Neither they nor I can, however, express adequately the esteem in which Faraday and his achievements are held by tens of thousands of men who count themselves as his disciples. Although I have formal authorization to speak only for my confrères in the United States, yet I feel quite safe in assuming, in a degree, to be the spokesman for men of science of whatever nationality. As such, I say to you of Britain that although Faraday was of your blood we of other lands yield you nothing in the measure of the respect and admiration in which we hold him. Go where you will in our institutions of learning, in the stately edifices we raise as homes for our scientific societies, or in the more prosaic housing of our scientific industrial establishments, and you will find everywhere the evidences of our regard. For us he is ever a great simple man who enriched the world as few others have been privileged to enrich it. In a way there is something peculiarly fitting in this tribute which I bring you, and especially in the manner of its delivery. Involved in it is probably more of the fruit of all Faraday's works than can be encompassed in any other single happening of our modern world. For me to sit here in Boston and address you in London requires the application of all that men have learned in a hundred years in the fields to which Faraday opened the gates. Looking back across the years from the vantage point of our present achievements, it seems incredible that such vast things could have had such modest beginnings as those simple experiments of a simple kindly man. And yet, as we look forward through the eyes of a faith that has been trained to see distant things, it is clear that we have but embarked on the voyage. When both you and I and those for whom I am speaking will long have passed to the great beyond, you may be assured that our descendants will join your descendants a hundred years hence when the time comes to commemorate another centenary of the man we are honouring to-day. For the present I can only reiterate that we in the far parts of the world are proud to have a spiritual part in your ceremonial.

* Received from Boston by transatlantic wireless telephony.